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Calf Respiratory Disease: I - some thoughts on the risk factors and their assessment by J R Starr.

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Introduction

Pritchard (1980) considers that we must recognise the multi-factorial aetiology of calf respiratory disease (CRD) and identify and investigate the risk factors.

Many such factors have been identified (Webster 1981). Within a particular enterprise the problem then becomes one of assessing not only of their effectiveness but ascribing a relative importance or weighting to such factors. Thus how relatively important in that enterprise are the influences of, say, nutrition and ventilation rate in encouraging CRD?

Let us first try to identify the 'bulk factors' influencing disease susceptibility.

Influences on Disease Susceptibility

From the outset it is useful to hypothesise that 'infection' is the 'natural state'. Health implies that animals live in a state of dynamic equilibrium with the pathogens; only when this state of 'equilibrium' is disturbed might 'disease' result. (Webster 1981).

[As an analogy: an ice block (disease susceptibility) may be held under water (i.e. controlled) by the judicious application of pressure from one's fingers (control factors). A relaxation of pressure from perhaps one or more fingers can upset this uneasy equilibrium and the block bobs to the surface, that surface representing the 'disease horizon'. Since the controlling factors may be independent of one another the 'fingers' could be envisaged as belonging to different people thus making the control of the block more difficult. Further, the animal's history and the quality of management are reflected in the irregular form of the block - different for each enterprise].

Let us express Disease Susceptibility (DS) as a function of the three variables:

H the initial 'health status' of the calves
M the quality of Management
and E the Environmental quality

$$\text{Thus } DS = f(H,M,E) \qquad \ldots (1)$$

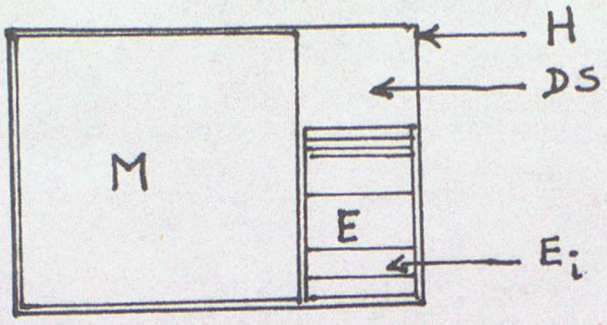
$$\text{and } H = f_H(\text{Age, origin, breed, history}\ldots) = f_H(H_1, H_2 \ldots H_m)$$

$$E = f_E(\text{housing, climate, nutrition, ventilation}\ldots) = f_E(E_1, E_2 \ldots E_n)$$

(f in (1) is such that high quality H, M & E gives low DS).

H defines the 'arena' within which M and E have to operate to reduce DS to an acceptably low level.

Diagrammatically:



Since we have noted that 'infection' is the 'natural state', we might regard the health status as roughly constant. Since it will be a function of calf origin, health, colostrum consumed, and the other 'on farm' infections this assumption of constancy clearly implies constant management procedures.

Estimate of Environmental Factors

Are not most E_i under the control, to a greater or lesser extent, of M?

i.e. $E_i = f_i(M)$

Thus ventilation, nutrition etc. might be considered as having been established by a management decision and not independent variables.

To even attempt to estimate the importance or relative 'weighting' of the various E_i we must regard a particular enterprise, 'warts and all', as having a particular standard of M which remains substantially consistent during the period of study. Thus M and H are essentially constants for the study; with M probably being more important than E (Excellent management is observed to give minimal DS even in what is considered as housing of inadequate standards).

The problems of a short period study on many farms or long period study on a very few are clear. In the former, M & H will probably be different for each enterprise while in the latter study, M may alter for various reasons. (Logistic problems will be severe in either case).

Averaging losses or disease treatment over many farms may smooth out the 'noise' of H and M variability and allow 'signals' to be detected in some E_i.

However the advantages of closely observing a few enterprises are clear and this scheme makes better use of limited resources and personnel too.

The Rational Decision Box

Assuming, then, the desirability of concentrating on a limited number of enterprises for a period such that M and H are deemed 'constants', we need a method of both assessing the relative importance (i.e.'weighting') of each E_i and of 'ranking' or quantifying the overall 'acceptability' of the environment from the point of view of 'disease risk'. A possible management aid here is the Rational Decision Box.

Let us list various environmental factors thought important in determining DS.

a) volume of air space per calf
b) air change rate.
c) air speed at calf height
d) climate (particularly rapid changes)
e) state of bedding (i.e. wet, dry,windy)
f) level of mites (thought to induce allergic reactions and hence encourage disease).

g) Nutrition
h) Microbiological (moulds, etc) and, particulate environment.
l) Relative Humidity , etc

This list may not be exhaustive but other factors may be purely a function of Management or functions of the listed factors.

Methods are available for quantifying some if not all these factors. (Ag. Memo 957 describes a multidisciplinary approach to evaluating these factors) and these quantities may be compared with recommended standards or levels (if such exist) on each visit to the enterprise.

Each factor can then be allocated a subjective classification (eg. 1 low quality to 5 high quality).

We are now in a position to fill in some elements in the Rational Decision Box.

Environmental factor or characteristic	Air volume per Calf (E_1)		Air change rate (E_2)	etc ...	E_n	Overall Acceptance
Weight	W_1		W_2	W_3	W_n	
Farm or Visit	Effectiveness	Acceptance	Acceptance	.....		
A	e_1	$e_1 \times W_1$	$e_2 \times W_2$		$e_n W_n$	$\sum_{i=1}^{n} e_i W_i$
B						
C						
D						
.						
.						
.						

Some factors may be easily quantified but will not have been obtained over the vital period in which disease is developing i.e. a high quality of a particular factor does not necessarily ensure it was ever thus or indeed that it is not offset by management e.g. high quality of nutrition may be offset by irregularity in feeding times or in cleansing containers.

'Climate' is a fairly subjective factor since it entails an estimate of the effect of topography and siting on ventilation under various meteorological conditions. Broadly a 'frost hollow' or 'hilltop' would be given a 'poor' rating, a hillside site, not over or under sheltered, a high rating although altitude and proximity to coasts may be brought into the assessment.

Weighting the environmental characteristics

Although the indications are that 'effectiviness' can be established for each E_i

at each visit the problem is one of making an educated guess as to their relative importance, W_i (on say a 1 to 5 scale) so that the 'acceptance' ($e_i \times W_i$) of that factor can be assessed. i.e. can we say whether ventilation shortcomings are more 'stressful' than those due to nutrition, and if they are, by how much.

Such weightings might be allocated by noting enterprises or occasions where CRD was a problem and inspecting the corresponding 'effectiveness' e_i of an environmental characteristic. Thus a low quality feed (or air change rate) in a house with infrequent CRD outbreaks would indicate that factor to have a low weighting (1 or 2). On the contrary if any E_i proved to be a common denominator in CRD-prone situations then that factor would rate a high weighting (4 or 5).

An 'acceptance' is calculated for each E_i as the product $e_i \times W_i$ and an Overall Acceptance of the environment is found on summing i.e. $\sum_n^i e_i W_i$ for each enterprise or visit.

In theory (with constant M) this index should have a close association with the incidence of CRD (i.e. highest incidence for lowest rankings). If not, weightings W_i, are awry and with sufficient data could be improved by a 'feed-back' technique by varying each W_i relative to the others until a 'good fit' is obtained corresponding to the CRD incidence.

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References

Pritchard DG (1980) Current research on calf pneumonia
Vet. Annu. 20, 189-203.

Roe CP (1982) A review of the environmental factors influencing calf respiratory disease
Agricultural Meteorology 26, 127-144.

Webster AJF (1981) Optimal housing criteria for ruminants: in Environmental Aspects of housing for animal production (Ed. J Clark)
Butterworths.

Please refer all comments to the author.

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